Trading zones, Interactional Expertise and the Future of Nanotechnology

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Nanotechnology

Requires Deep Expertise from
Multiple Disciplines plus
collaboration

Collaboration combines social and technical

The 21st Century Nanotechnology Research and Development Act calls for "integrating research on societal, ethical, and environmental concerns with nanotechnology research and development, and ensuring that advances in nanotechnology bring about improvements in quality of life for all Americans"

Problem of Incommensurability (Kuhn)

- Experts in an old paradigm may not be able to communicate with those in a new

- Participants from different disciplinary cultures may not be able to communicate with each other

- Making it impossible to work towards a common goal

Trading Zone as solution to incommensurablity

- Galison-- radar, particle accelerators--scientists and engineers develop a creole to communicate
- *Nanocajun*
- Lambert--JPL engineers refer to their negotiations as trades
- Baird--early in the development of MRI, surgeons interpreted an artifact as a lesion
  - Solved by someone with background in both physics and surgery
  - Interactional expert

Example of trading zones begetting trading zones

When trading zones fail

- Boeing engineers who wanted to be respected by management, evolve shared goals
  - Airplanes as boundary objects: engineers as designers or assemblers?
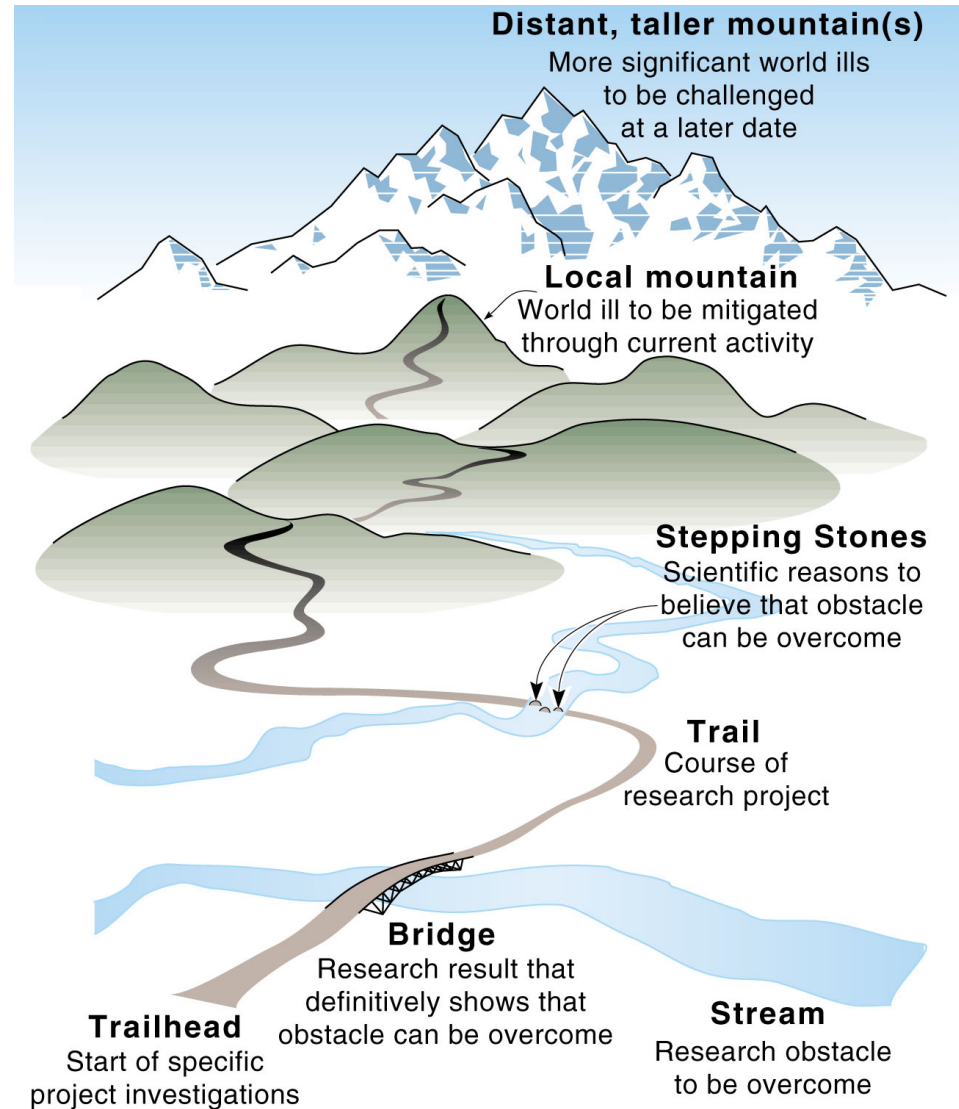- Ed Wells Institute as boundary organization (Guston)

A Small Nanotechnology Trading Zone

Goal: to explore how scientists, engineers, ethicists and social scientists could collaborate on nanotechnology research

- Student entering the UVA MRSEC had two advisors: a materials scientist (Groves) and a social scientist (Gorman). Together, we explored how depositing nanodots of one metal oxide on another can be directed toward 'world ills'
  - Medical or environmental sensors
- All three of us keep diaries of our cognitive processes and send them to a cognitive scientist (*Shrager*)
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Metaphor: Mountains and Bridges

Distant, taller mountain(s)
More significant world ills
to be challenged
at a later date

Local mountain
World ill to be mitigated
through current activity

Stepping Stones
Scientific reasons to
believe that obstacle
can be overcome

Trail
Course of
research project

Bridge
Research result that
definitively shows that
obstacle can be overcome

Trailhead
Start of specific
project investigations

Stream
Research obstacle
to be overcome

Three levels of shared expertise in multidisciplinary trading zones (adapted from Collins and Evans)

- None--participants speak different languages, or use the same terms in incommensurable ways

- Interactional--an expert in one discipline who can facilitate trades with others

- Contributing--an expert who masters a new domain enough to make an original contribution

Trajectory of Gorman's expertise in nanotechnology

- None--where G started before project
- Interactional--after learning about guided self-assembly and metal oxides, G had the judgment to help shape the research strategy but not the skill to do experiments
- Contributing--G's name is on a patent application

Environmental regulation and emerging technologies

- The potential environmental impacts of new technologies need to be monitored and negotiated with agencies like EPA (Nora Savage), with environmental scientists and with multiple stakeholders
  - Fish & wildlife, fisherfolk & bycatch (Kiki Jenkins)
- Current environmental regulations are not adequate for nanotechnology (Wardak & Rejeski)
  - Regulatory assumption that nanoparticles can be classified and treated like their macro-scale counterparts

The impacts of breakthrough technologies on complex systems are not entirely predictable, therefore

State 3: Adaptive management of a reflexive historical system

The Earth Systems Engineer has "to be in continued dialog with the creation that we are responsible for, and part of"—creating "new and more self-aware cognitive systems".

Brad Allenby

Service Science: Managing coupled human-technological systems

- Represents a new kind of interactional expertise that combines technical and business knowledge with cognitive and social psychology
- Service scientists should facilitate human-technological co-evolution that enhances human capabilities, world-wide
- Involves trading zones that may become collaborations

Jim Spohrer, IBM Almaden

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

But values are often based on incommensurable ideological differences

Prohibiting any kind of agreement on ethical outcomes, unless participants exercise

Moral Imagination

- We learn practical ethics from stories, which become mental models for virtuous behavior
- These mental models can become unquestioned assumptions--'realities'
- Moral imagination consists of seeing that these realities are like hypotheses about how to live, and that alternative hypotheses, e.g., those of other stakeholders, are worth understanding
  - Lincoln understood why the South was dependent on slavery
- NOT relativism--the hope is to evolve improved ethical frameworks

Moral Imagination & Nanotechnology

- Envisioning the future of nanotechnology is an act of imagination that requires consideration of societal dimensions

- Including how nanotechnology would be viewed from multiple perspectives.

- This kind of reflection permits stakeholders to imagine alternate possibilities

- And evaluate results of pursuing such possibilities